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Station Paper No. 95

September 1958

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U. S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE

CONTROL OF CULL TREES AND WEED SPECIES IN HARDWOOD STANDS

by

Earl R. Sluder
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INTRODUCTION

Cull trees and non-commercial species have long been a problem in forest management. This is especially true in the Southern Appalachians where past logging, fire, and chestnut blight have seriously depleted the stands, leaving a high percentage of non-merchantable volume.

Hardwood cull volume is still increasing. The Southeastern Station Annual Report for 1956 states that in the southeast hardwood cull volume has increased 36 percent since 1937. The Forest Survey (8) shows that in 1955 12.5 percent of all hardwood trees in the mountain areas of North Carolina were cull. This means that about one-eighth of the growing space in these forest stands is taken up by trees that are of little or no value. Of course, it is impossible to maintain a forest free of cull trees, but the stands in their present condition are growing far less merchantable volume than they are capable of growing.

Both public and private foresters are aware of this condition and have active programs of timber stand improvement. Much work has already been done, but in view of what needs to be done, the surface has barely been scratched.

Some chemical hardwood control has been practiced for many years. The recent trend is away from the highly toxic chemicals, such as sodium arsenite, to the chemicals with little or no toxicity, such as Ammate, 2, 4, 5-T, and 2, 4-D, which have been developed since World War II. Method of application to individual trees has generally been in notches or frill-girdles made with an ax. Two recent developments, mechanical tree girdlers and improved tree injectors, are proving very effective as tools for hardwood control, and are growing in popularity.

PAST WORK

Sodium Arsenite

Sodium arsenite was one of the earliest chemicals to be used for hardwood control. It is very effective but is so highly toxic that it is dangerous to use. However, it is still being used for special cases.

Sodium arsenite is more effective than Ammate for treatment of bottomland hardwoods, such as bitter pecan (11), but is no better than Ammate for upland scrub oaks (15) ("effective" means that the crown was killed and little or no sprout growth resulted). Rushmore (16) found that sodium arsenite solution applied in holes bored in American beech killed the trees and a large percentage of the root sprouts. In later studies (17) he found that a 50-percent water solution of sodium arsenite in ax cuts spaced with 4 inches of unsevered bark between them gave fast kill for red maple when applied in summer and for beech regardless of season of application.

Sodium arsenite has been used for bark peeling on pulpwood trees. Swain (19) reports good results on white pine with impregnated paper tabs inserted under the bark. In a test in northeast Mississippi, a 40-percent aqueous solution applied in girdles gave good kill and peeling for red oak, white oak, sweetgum, shortleaf pine, and loblolly pine, but not for hickory (20). Insects and fungi caused serious damage to these treated trees, making them undesirable for pulpwood.

Ammate

Ammate has been very effective for many species when applied in cups, on stumps, or in frills. Ammate crystals in cups are more effective than Ammate solution in frills for sprout control on southern upland hardwoods, such as scrub oaks, oaks, hickories, black gum, and sweetgum (14). Ammate crystals and Ammate solution proved highly effective on post oak when applied to freshly cut stumps (12). In New Jersey, Ammate crystals were applied on stumps and in cups on dogwood, sugar maple, red maple, elm, black cherry, blackhaw, ash, and spicebush. Results were good on all species except ash and red maple (6).

2, 4, 5-T

Tests show 2, 4, 5-T is effective on many species. Various application methods have been used, but in general, oil solutions are more effective than water solutions on most species, especially during the dormant season (2, 18).

Water solutions in frills have been effective on some of the southern hardwoods (2, 10). Grano (3) found that good results were obtained on southern red oaks with a 1-percent water solution of 2, 4, 5-T in frills, regardless of season of application.

A mixture of 2, 4, 5-T in oil applied in frills on American beech, American holly, sweetgum, American hornbean, white oaks, hickories, winged elm, red oaks, and white ash resulted in a good kill on all species except American holly (7). In kill and sprout control on oaks in Missouri, an oil solution of 2, 4, 5-T applied in low frills was more effective than a waist-high notch girdle alone (13). Arend (1) reports better results with frills near the ground, and also that best results were obtained with treatments in the summer and fall.

Oil solutions of 2, 4, 5-T have been used with various girdling treatments, on stumps, and as basal sprays: McCully (9) reports satisfactory results for post oak with still another method of application: injection of the silvicide into the soil to be taken up by the roots.

Girdling

Tests show that most hardwoods larger than 11 or 12 inches in diameter can be killed by girdling without a silvicide and that very little sprouting results (5). Greth (4) found that large trees (11 inches and larger in diameter) of hickory, white oak, black oak, red oak, scarlet oak, blackjack oak, blackgum, and post oak could be killed by notch girdling with an ax, but that pole-size trees (5 to 11 inches in diameter) could not.

Many of these treatments are probably applicable in the Southern Appalachians, but tests are needed to determine which treatments, dosages, and chemicals are most effective on the mountain species.

THE STUDY

This study was designed to test several methods of killing unwanted trees and shrubs in hardwood stands in the Appalachians. The six most important species or species groups in timber stand improvement work in the mountain areas were used: red maple (*Acer rubrum*), sourwood (*Oxydendron arboreum*), laurel (*Kalmia latifolia*), rhododendron (*Rhododendron maximum*), oaks (*Quercus alba*, *Q. velutina*, *Q. stellata*, *Q. coccinea*, *Q. rubra*, *Q. prinus*, *Q. falcata*), and hickories (*Carya ovata*, *C. tomentosa*, *C. glabra*, *C. cordiformis*). The study was installed on the Bent Creek Experimental Forest near Asheville, North Carolina, in the spring of 1955.

Three size groups were used in the study: small, 0.6 to 4.9 inches in diameter; medium, 5.0 to 11.9 inches in diameter; and large, 12.0 inches and larger in diameter. All six species or species groups were used in the small-size group; oaks, hickories, red maple, and sourwood were used in the medium-size group; and oaks and hickories were used in the large-size group. Ten trees of each species or species group were used for each treatment, replicated on each of two blocks.

Table 1 lists the treatments used for each size group. The treatments are illustrated in figures 1 and 2.

The study was established in the spring of 1955. Examinations were made in August or September of each of the three subsequent growing seasons.

Table 1.--Treatments used for each size group

SMALL TREES (0.6 TO 4.9 INCHES IN DIAMETER)

Treatment number	Treatment	Concentration
I	Basal spray, 2, 4, 5-T[1] (oil)	20 lbs. ahg (acid equivalent per hundred gals.)
II	Stumps (no silvicide)	---
III	Stumps, 2, 4, 5-T (oil)	20 lbs. ahg
IV	Stumps, Ammate crystals	1 tbsp. /2 inches d.b.h.

MEDIUM AND LARGE TREES (5.0 INCHES AND LARGER IN DIAMETER)

Treatment number	Treatment	Concentration
V	Cups, Ammate crystals	1 tbsp. per cup
VI	Notch-girdle (ax)	---
VII	Machine-girdle	---
VIII	Ax-frills, 2, 4, 5-T (H_2O)	8 lbs. ahg
IX	Ax-frills, 2, 4, 5-T (H_2O + wet. agt.)	8 lbs. ahg
X	Ax-frills, 2, 4, 5-T (oil)	8 lbs. ahg
XI	Machine-girdle 2, 4, 5-T (oil)	20 lbs. ahg

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[1] A low-volatile butyl ether ester of 2, 4, 5-T was used.

Treatment I

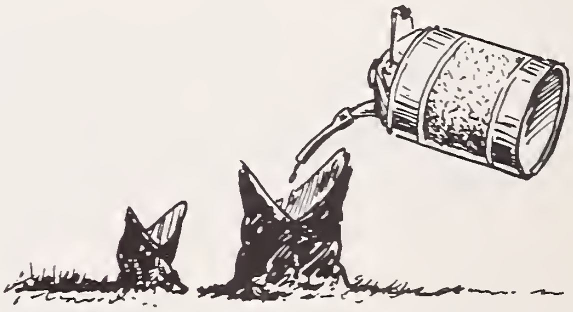
The base of the tree was thoroughly wetted with the silvicide.

Treatment II

Control. The trees were cut and no silvicide was applied.

Treatment III

The trees were cut and the stumps thoroughly soaked with the silvicide.



Treatment IV

Ammate crystals were placed in the V-notches that were made when the trees were cut.

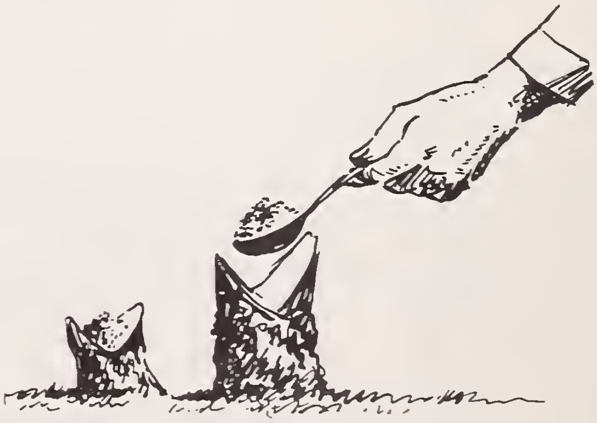
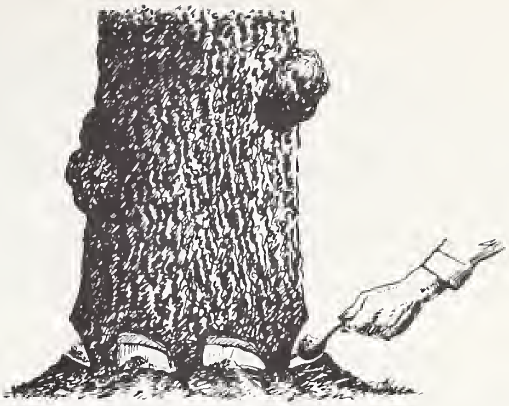


Figure 1.--Treatments used on trees smaller than 5 inches in diameter.

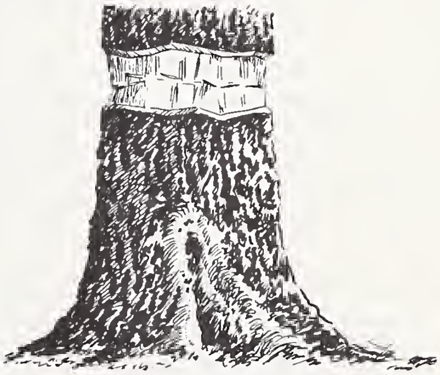
Treatment V

Ammate crystals were placed in cups made with an ax in the base of the tree.



Treatment VI

Control. A section of the bark was removed around the tree and no silvicide was applied.

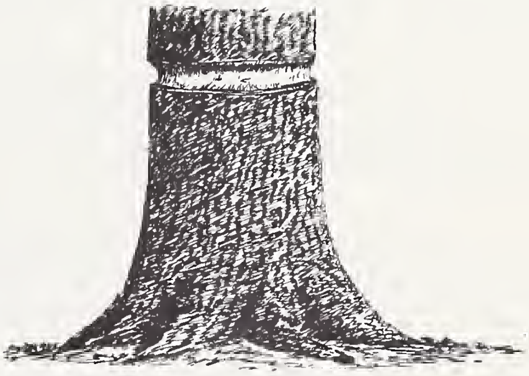


Treatment VII

Control. A complete girdle was made with a girdling machine and no silvicide was applied.

Treatment XI

Silvicide was applied in the girdle.



Treatments VIII through X

Frills, made by hacking downward with an ax, were filled with the silvicide.

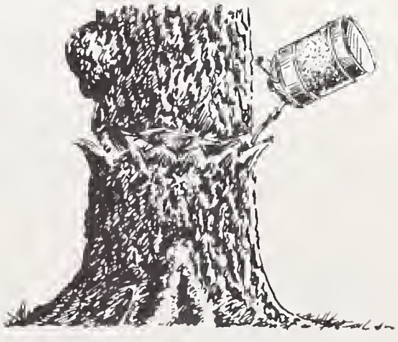


Figure 2.--Treatments used on trees larger than 5 inches in diameter.

RESULTS

An analysis of variance showed a significant difference in sprouting on the two blocks. In general, sprouting was more profuse on Block B than on Block A. Since Block A is relatively flat and 2,500 feet in elevation, while Block B is steep with a northeast aspect and is 3,000 feet in elevation, several factors are probably involved in this block difference, such as elevation, slope, aspect, soil, and precipitation. Because the study was established over a period extending from March 9 to May 9, some of the variation may have been caused by change of season.

Results were measured in terms of percent of crown kill, number of sprouts, length of tallest sprout, and total length of sprouts. In discussions of sprout results in this report, only the number of sprouts will be used, since the treatments that resulted in the lowest number of sprouts per tree also gave the lowest values per tree for the other two measurements of sprout results.

In a discussion of hardwood control, it would be very desirable to know just what constitutes satisfactory or acceptable results. Complete crown kill and sprout control is of course desirable, but very seldom can be obtained in a reasonable length of time. What limits, then, are acceptable? Any line that might be drawn would be at least partly arbitrary.

Another approach would be to determine at what point a treated tree is no longer competing seriously with the desirable trees in the stand, or with reproduction. A tree crown that is 75- or 80-percent killed should no longer present any serious competition with surrounding trees; neither should a few weak sprouts be a serious problem. In view of these limits, any treatment that kills 75 to 80 percent of the treated canopy and prevents heavy sprouting would be considered effective, or satisfactory.

Satisfactory crown kill does not necessarily mean satisfactory sprout control, and vice versa. Crown kill and sprout growth results should each be considered in view of the other.

In this report, percent crown kill means an average percent crown kill for the entire group of trees in the category. For instance, an average crown kill of 50 percent may include trees with no crown kill to trees with 100-percent crown kill. In table 2, however, the percent crown kill is further broken down into percent of trees with total crown kill and an average percent of crown kill for the remainder. The table also shows the total average percent of crown kill and the average number of sprouts. Table 3 gives the sprouting results for the stump treatments on trees in the small-size group.

Small-Size Groups (0.6 to 4.9 Inches in Diameter)

Oak.--Treatment I (basal spray, 2,4,5-T in oil) gave good results (74-percent crown kill and 4 sprouts per tree). Treatment IV (stumps, Ammate crystals) gave very good sprout control.

Hickory.--The basal spray treatment did not give satisfactory results for hickory (56-percent crown kill). Treatment III (stumps, 2,4,5-T in oil) gave the best sprout control of the other three treatments.

Table 2.--Treatment results by species and size groups

Species	Treatment	Average percent crown kill	Percent of trees with total crown kill	Average percent crown dead, remainder	Average number of sprouts
SMALL-SIZE GROUP (0.6 to 4.9 INCHES IN DIAMETER)					
Oak	I	74	72	19	4
Hickory	I	56	53	12	2
Red maple	I	81	72	31	4
Sourwood	I	20	11	12	0.4
Rhododendron	I	22	15	15	4
Laurel	I	89	70	65	.4
MEDIUM-SIZE GROUP (5.0 TO 11.9 INCHES IN DIAMETER)					
Oak	V	100	100	--	0
	VI	92	83	65	38
	VII	96	85	78	12
	VIII	87	70	59	14
	IX	88	80	42	28
	X	100	100	--	7
	XI	98	90	80	12
Hickory	V	43	30	19	1
	VI	86	68	56	10
	VII	67	59	41	8
	VIII	95	90	60	8
	IX	100	100	--	11
	X	100	100	--	2
	XI	92	75	80	6
Red maple	V	51	29	33	9
	VI	62	20	54	28
	VII	55	0	55	37
	VIII	57	30	40	35
	IX	61	26	49	28
	X	66	32	53	35
	XI	53	10	49	21
Sourwood	V	96	95	30	3
	VI	59	30	59	25
	VII	61	15	55	21
	VIII	62	28	51	16
	IX	67	26	56	25
	X	93	84	73	24
	XI	54	17	45	14
LARGE-SIZE GROUP (12.0 INCHES AND LARGER IN DIAMETER)					
Oak	V	91	85	47	0
	VI	96	90	60	2
	VII	99	95	80	5
	VIII	100	100	--	14
	IX	89	80	47	5
	X	100	100	--	1
	XI	92	80	62	5
Hickory	V	30	10	27	1
	VI	94	80	76	3
	VII	86	80	39	1
	VIII	87	60	72	1
	IX	96	84	82	0.4
	X	100	100	--	6
	XI	60	45	29	2

Table 3.--Average number sprouts for stump treatments on small trees (0.6 to 4.9 inches in diameter)

Treatment	Oak	Hickory	Red maple	Sourwood	Rhododendron	Laurel
II	10	7	19	12	34	33
III	9	3	11	6	8	4
IV	3	4	7	6	14	46

Red maple.--A basal spray of 2, 4, 5-T in oil gave good crown kill (81.5 percent) and low sprouting for red maple. None of the stump treatments was satisfactory.

Sourwood.--Ammate crystals on stumps is the only treatment that gave satisfactory results for sourwood in this size group.

Rhododendron.--Stumps treated with 2, 4, 5-T in oil gave very good sprout control for this species. None of the other treatments was satisfactory.

Laurel.--2, 4, 5-T in oil applied as a basal spray gave 89-percent crown kill and excellent sprout control for laurel. Stumps treated with 2, 4, 5-T in oil had an average of only 4 sprouts per stump.

Medium-Size Groups (5.0 to 11.9 Inches in Diameter)

Oak.--All treatments gave good crown kill, but treatments V (Ammate in cups) and X (ax-frills, 2, 4, 5-T in oil) gave best sprout control. There were no sprouts with treatment V and only 7 sprouts per tree for treatment X.

Hickory.--Treatments VIII (ax-frills, 2, 4, 5-T in water), IX (ax-frills, 2, 4, 5-T in water plus a wetting agent), X (ax-frills, 2, 4, 5-T in oil), and XI (machine-girdle, 2, 4, 5-T in oil) gave good crown kill for hickory, but treatment X (ax-frills, 2, 4, 5-T in oil) showed the best sprout control (2 sprouts per tree).

Red maple.--This species proved hard to kill by any of the treatments tested. Crown kill did not vary appreciably from about 55 percent and sprouting was profuse with all treatments.

Sourwood.--Treatment V (cups and Ammate) gave satisfactory results for this species (96-percent crown kill and 3 sprouts per tree). Treatment X (ax-frills, 2, 4, 5-T in oil) gave good crown kill, but did not control sprouting.

Desirable results on medium-size trees are illustrated in figure 3.

Large-Size Groups (12.0 Inches and Larger in Diameter)

Oak.--Good results were obtained with all treatments used, with the exception of heavy sprouting in treatments VII (machine-girdle) and VIII (ax-frills, 2, 4, 5-T in oil).

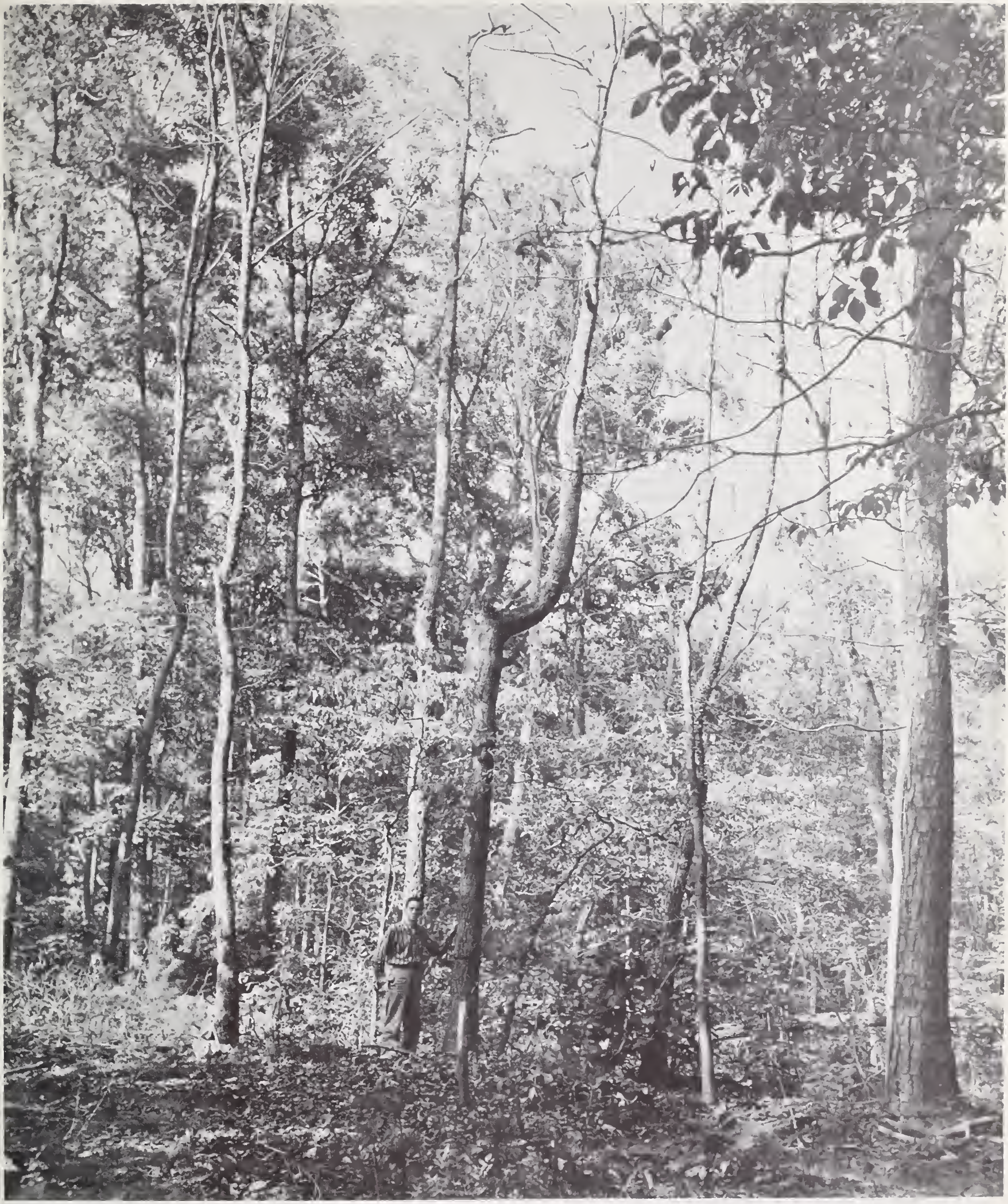


Figure 3.--These treated trees no longer compete with more desirable trees and seedlings.

Hickory.--Treatment IX (ax-frills, 2, 4, 5-T in H_20 + wetting agent) gave the best overall results for hickory. Ammate in cups (treatment V) gave very low crown kill (30 percent). There was a tendency for this species to bridge over the machine-girdle in treatments VII (machine-girdle--10-percent bridging) and XI (machine-girdle, 2, 4, 5-T in oil--20-percent bridging). This resulted in a lower crown kill for these two treatments (86 percent for treatment VII and 60 percent for treatment XI). The eradication of a few large cull and wolf trees releases many smaller trees, as illustrated in figure 4.

CONCLUSIONS

No one treatment is effective on all species over all size groups. Of the species tested, red maple and rhododendron are the most difficult to control. Listed below are the treatments recommended for each species and size group:

Species	Size	Treatment
Oak	Small	Stumps, Ammate crystals, 1 tbsp./2" d.b.h.
	Medium	Cups, Ammate crystals, 1 tbsp./cup, no.cups = ½ d.b.h.; or ax-frills, 2, 4, 5-T in oil, 8 lbs. ahg.
	Large	Any good girdling treatment, silvicide not necessary.
Hickory	Small	Stumps, 2, 4, 5-T in oil, 20 lbs. ahg or Ammate crystals, 1 tbsp./2" d.b.h.
	Medium	Ax-frills, 2, 4, 5-T in oil, 8 lbs. ahg.
	Large	Ax-girdle (frill or notch) silvicide not necessary.
Red maple	Small	Basal spray, 2, 4, 5-T in oil, 20 lbs. ahg.
	Medium	No treatment was satisfactory.
Sourwood	Small	Stumps, Ammate crystals, 1 tbsp./2" d.b.h.
	Medium	Cups, Ammate crystals, 1 tbsp./cup, no.cups = ½ d.b.h.
Rhododendron	---	Stumps, 2, 4, 5-T in oil, 20 lbs. ahg.
Laurel	---	2, 4, 5-T in oil, 20 lbs. ahg on stumps or as basal spray.

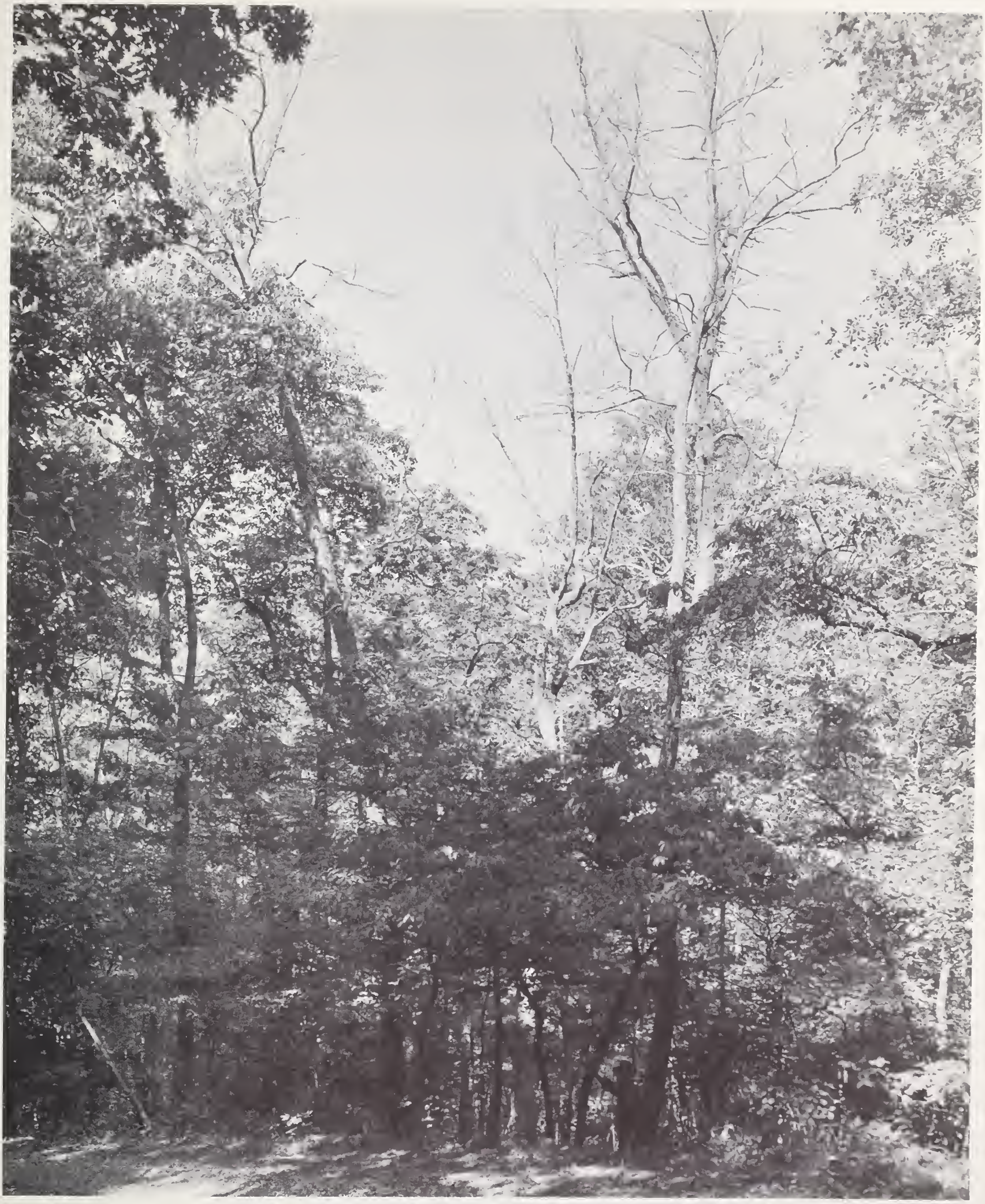


Figure 4.--The crowns of these large oak and hickory trees are beginning to break up three growing seasons after treatment. Sunlight can now reach the smaller trees and forest floor.

SUMMARY

In the spring of 1955, a study was established at the Bent Creek Experimental Forest to test several methods of hardwood control. Oaks, hickories, red maple, sourwood, rhododendron, and laurel were treated. Results were measured three growing seasons after treatment.

The treated trees were divided into three size groups: small (0.6 to 4.9 inches in diameter), medium (5.0 to 11.9 inches in diameter), and large (12.0 inches and larger in diameter). In the small-size group, best treatments were a 2, 4, 5-T in oil basal spray for red maple and laurel, stumps treated with 2, 4, 5-T in oil for hickories and rhododendron, and stumps treated with Ammate crystals for oaks and sourwood. In the medium-size group, Ammate in cups was best for oaks and sourwood, ax-frills treated with 2, 4, 5-T was best for hickories, and none of the treatments was satisfactory for red maple. Oaks and hickories in the large-size group were successfully killed by girdling alone. However, the hickories tended to bridge over the machine-girdle, but did not bridge over the notch-girdle made with an ax.

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